

ETV Evaluations of Market-Ready Technologies for Arsenic Removal in Drinking Water

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Environmental Issue

Arsenic in drinking water is a known carcinogen with additional adverse human health impacts. For the 4,100 effected systems, 37 to 55 cancer cases per year are estimated, with about half projected to result in deaths if treatment solutions are not implemented.

How well do some commercially-marketed package drinking water treatment systems perform to reduce arsenic below the 10 ppb regulatory standard, and also reduce other contaminants in drinking water?

Science Approach

The Environmental Technology Verification (ETV) Drinking Water Systems (DWS) Center is a partnership between the U.S. Environmental Protection Agency (EPA) ORD, and NSF International to provide independent evaluations of water treatment technologies. The Center helps state agencies, utilities, and scientific and engineering organizations to find and implement solutions to comply with current and anticipated drinking water regulations. ETV is conducting evaluations of technologies for the removal of arsenic in drinking water at several field sites across the United States. Studies are conducted by independent organizations, with audits and oversight during the testing provided by NSF and EPA. Test data and final reports are peer-reviewed for quality and engineering issues by external reviewers, NSF, and EPA. The ETV DWS Center has completed verifications of eight market-ready technologies, and additional studies are ongoing. Studies focus on water quality performance and operations & maintenance issues associated with a number of technology categories.

Collaborative Efforts

A diverse stakeholder group composed of Federal & State Health Agencies, vendor & trade organizations, academia & engineering groups, and user representatives offer recommendations for prioritizing technology testing issues. Testing protocols are developed by independent experts and reviewed and revised through a stakeholder process. This provides uniform test plans with well defined quality assurance criteria for consistent technology evaluation and analysis of results. The cost of testing and reporting is shared between EPA, the vendor, and some funds and resources leveraged from States and other research organizations.



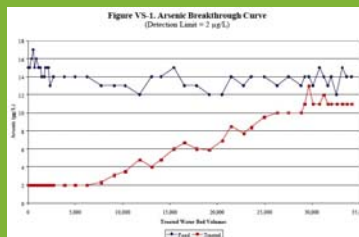
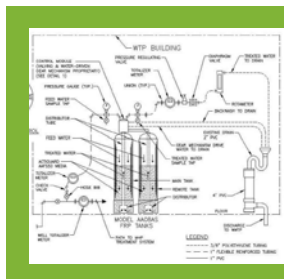
Testing of the ADI adsorption media filter system with iron-based MEDIA G200 was conducted in Sellersville, Pennsylvania. The system was operated at 1.7 gpm, 24 Hrs/day for about 8 months. Raw water was disinfected with sodium hypochlorite and treated with sulfuric acid to lower the pH from 7.6 to 6.4. The system reduced arsenic from an average of 21 ppb in the feed water to an average of 7 ppb in the treated water. Fifteen filter backwashes and one media regeneration were performed.



Testing of the Kinetico Macrolite 5 gpm Coagulation and Filtration System was conducted at Park City, Utah. NaOCl and FeCl₃ convert arsenate to a precipitate that is removed by the proprietary ceramic media. The system initiates backwashing based on filter headloss or turbidity criteria. The system reduced total arsenic from an average feed of 71 ppb to less than 3 ppb.



The Watts Premier M-15,000 RO System was conducted at Coachella Valley, Thermal, California. The system contains six reverse osmosis membrane modules operated at a flux of 34 gfd, 135 psi, 53% recovery, and specific flux 0.36 gfd/psi. The pre-filter contains a sediment or GAC cartridge. The system reduced total arsenic from an average 14 ppb to 1 ppb. The system also removed on average 72% barium, 92% chromium, 90% sulfate, 93% vanadium, 85% fluoride, 85% chloride, 38% iron, and 62% silica.



Testing of the Kinetic and Alcan Para-Flo PF60 Model AA08AS with Actiguard AAFS50 2 gpm adsorptive media filter system was conducted at the Orchard Hills Mobile Home Park, Carroll Township, Pennsylvania. The average total arsenic of 14 ppb was removed to less than detection for 8,000 bed volumes, to less than 10 ppb for 25,000 bed volumes, to 11ppb at 29,000 bed volumes over 2,350 hours of operation. Also, manganese was reduced by 92%. No chemicals or electrical power were required. Backwash water was discharged to sanitary sewer, and waste TCLP and CA WET results were less than regulatory limits.



Testing of the 1 gpm WaterMark LLC eVox Model 5 Coagulation and Multimedia Filtration System was conducted at Park City, Utah. Chemical addition included ferric chloride and sodium hypochlorite. The system reduced total arsenic from an average of 77 ppb to 4 ppb. Iron was removed from a feed of 268 ppb to below detection. Backwash frequency was set at four hours.



Testing of the Hydranautics ESPA2-4040 Reverse Osmosis Membrane System was conducted at Park City, Utah. The unit was operated at 150 psi, recovery of 15%, and specific flux of 0.15 gfd/psi (25°C). The system removed total arsenic in the feedwater from 65 ppb to below 1 ppb in the treated water. There was no significant fouling of the membrane during the test period.



The Delta Industrial Services, Inc. CampWater Porta-5 system was evaluated at a small community in Anchorage, Alaska. The system utilizes ozone to oxidize iron and arsenic (III) to arsenic (V). The arsenic bound to the iron precipitates is then removed by cartridge filtration. No additional flocculation, solids separation or clarification is required. The CampWater system was tested on a ground water source with 27 µg/L arsenic and 0.62 mg/L iron. The system was evaluated under various operating conditions, and arsenic was reduced to below 10 ppb.

Partnerships

- NSF International coordinates technology testing activities;
- Industry organizations provide feedback and support, i.e., Association of State Drinking Water Administrators, American Water Works Assoc., National Rural Water Assoc., Water Quality Assoc., Water & Wastewater Manufacturers Assoc., Office of Groundwater and Drinking Water;
- Test Protocols submitted to all 50 States for review;
- Several Science and Engineering organizations conduct field testing studies;
- Some State Agencies provide resources to ETV activities:
 - Utah: \$25K for Lab analyses
 - Pennsylvania: \$30K Lab, \$20K cash
 - Alaska: \$50K Lab & field testing
 - California: in-kind support, additional State certification
 - Michigan: in-kind support and reviews

Outcomes & Impacts

ETV provides information to help states, utilities, and other organizations select appropriate water treatment technologies to meet the 10 ppb arsenic regulatory standard. Many of the ETV verified technologies demonstrated the capability to reduce arsenic levels in drinking water to 5 ppb or less. This provides several available alternatives for off-the-shelf technology products to the estimated 3,900 smaller drinking water systems anticipated to be required to install treatment to meet the new arsenic standard. State agencies have indicated ETV studies may also help to minimize pilot testing requirements and help expedite the approval and implementation of technologies at sites. Also, ETV results help provide technology vendors with valuable data on product weaknesses that may be addressed in subsequent product modifications.

One case study estimates that for a 10% market penetration of ETV technologies, the cancer cases and deaths prevented may result in health benefits of \$4.8M- \$6.8M per year. In addition, a reduction in pilot testing may provide an estimated total national savings up to \$7.8M.



The Pall Microza Microfiltration System is being evaluated in Oakland County, Michigan. It includes pretreatment with sodium hypochlorite to oxidize any arsenic (III) to arsenic (V), and iron present in the water supply. Ferric chloride may be added to augment any natural occurring iron and optimize the iron dose. Sulfuric acid will be added to adjust the PH.



Testing of the Koch TFC® - ULP4 Reverse Osmosis Membrane System was conducted at Park City, Utah. The unit was operated at 150 psi inlet pressure, a recovery of 15%, and a specific flux of 0.24-0.27 gfd/psi (25°C). Total arsenic feedwater ranging from 48 to 77 ppb was reduced to below 1 ppb.



Mention of trade names or commercial products does not constitute endorsement.



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